

KEY ISSUES IN INTEGRATED RESOURCE PLANNING FOR ELECTRIC UTILITIES

Eric Hirst
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831

Charles Goldman
Lawrence Berkeley Laboratory
Berkeley, California 94720

Abstract - Integrated resource planning (IRP) is a new way for utilities and state regulatory commissions to consistently assess a variety of demand and supply resources to cost-effectively meet customer energy-service needs. This paper reviews recent progress in IRP and identifies the need for additional work by utilities, regulatory commissions, and other organizations.

Keywords: demand-side management, electric, planning, regulation, resources, utilities.

OVERVIEW

Electric utilities are undergoing fundamental changes. These changes include deregulation of electricity generation; greater access to transmission systems; competition for retail customers; changes in economic regulation; increased concern with the environmental consequences of electricity production and use; growing public opposition to construction of power plants and transmission lines; and considerable uncertainty about future load growth, fossil-fuel prices and availability, and the costs and construction times for different kinds of resources. IRP is a new and evolving process that can help utilities and state public utility commissions (PUCs) deal with these changes. IRP consistently assesses various demand and supply resources to meet customer energy-service needs at the lowest economic and social cost. IRP is important to utilities, their customers, and PUCs [1, 2, 3] primarily because of problems that arose with traditional planning methods. These problems included a narrow focus on central-station power plants, limited consideration of uncertainty, and little public involvement.

The study summarized here was prepared for the U.S. Department of Energy (DOE), which manages a program on Least-Cost Utility Planning (LCUP). DOE asked Lawrence Berkeley Laboratory (LBL) and Oak Ridge National Laboratory (ORNL) to review IRP progress

during the past few years and to identify the need for additional work. This review, the outline of which is shown in Table 1, is based on the judgment and experience of LBL and ORNL staff, supplemented by comments from about 30 people in utilities, PUCs, DOE, and public interest groups [4].

The rest of this section briefly describes the IRP process. The following sections discuss the five most important topics from the LBL/ORNL study that deserve additional attention. The recommendations on future work are meant to guide further development of IRP processes, techniques, and data so that the benefits IRP can yield for energy consumers, government agencies, utilities, and the nation as a whole are realized.

Typically, a utility begins its IRP process by developing alternative load forecasts (top part of Fig. 1). Next, the utility assesses the costs and remaining lifetimes of its existing resources, and identifies the need for additional energy and capacity resources.

The utility then assesses a broad array of alternatives that could satisfy the need for new resources (middle of Fig. 1), including supply, demand, transmission, distribution, and pricing alternatives. These analyses are repeated using (1) different assumptions about the external environment (e.g., local economic growth and fossil-fuel prices) and about the costs and performance of different resources and (2) different combinations of resources. This uncertainty analysis helps to identify a mix of resource options that meets the growing demand for electricity, is consistent with the utility's corporate goals, avoids exposure to undue risks, and satisfies other environmental and social criteria.

After approval by the PUC (or other administrative body, for public utilities), the plan is implemented and resources are acquired (bottom of Fig. 1). While the plan is in force, the utility monitors changes in its environment and its implementation of the resource plan, and the plan is modified as events and opportunities change over time.

90 WM 100-3 PWRs A paper recommended and approved by the IEEE Power System Engineering Committee of the IEEE Power Engineering Society for presentation at the IEEE/PES 1990 Winter Meeting, Atlanta, Georgia, February 4 - 8, 1990. Manuscript submitted August 7, 1989; made available for printing December 27, 1989.

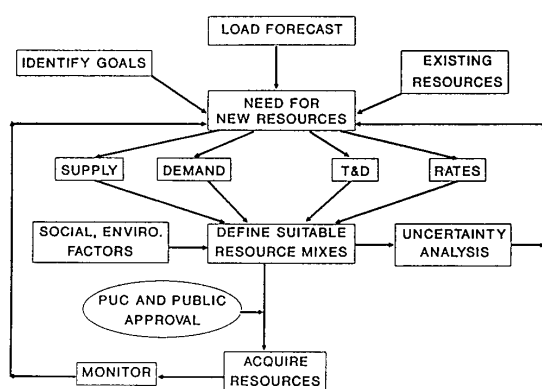


Fig. 1. Schematic showing the activities involved in integrated resource planning.

Table 1. Key areas in utility integrated resource planning covered in the LBL/ORNL report

The process of integrated resource planning
Tracking and documenting approaches to IRP
Stimulating collaborations and networking
Decoupling electricity sales and earnings
Deregulation and competition
Broadening the scope of integrated resource planning
Bidding for demand-side resources
Electricity pricing as a "resource"
Extending IRP to other fuels
Incorporating environmental and social factors
Advancing the techniques of integrated resource planning
Demand-side inputs to integrated resource planning
End-use load shapes and other baseline data
Assessment of demand-side technologies
Program experience and market penetration
Technology transfer

REWARDING UTILITIES FOR SUCCESSFUL IRP IMPLEMENTATION

PUCs want utilities to develop and implement an IRP process in which demand and supply resources compete on an equal basis. However, the traditional way that PUCs set electric rates discourages utilities from making optimal use of demand-side management (DSM) options, especially energy-efficiency measures. Under the

ratemaking formulas used in most states, utility earnings increase (between rate cases) when electricity sales increase. This occurs because incremental revenues cover the utility's fixed and variable costs but incremental costs contain only short-run variable costs. In contrast, implementing DSM programs reduces sales, which decreases the company's revenues and profits. Utilities are also concerned with potential price increases (caused by the need to spread fixed costs over fewer kWh sales) that would reduce their competitiveness.

These disincentives are the driving forces in ongoing debates over the need to reform the ratemaking process. Proponents of reform argue that IRP is likely to be successful only if ways are found to align the financial interest of the utility with the goals of integrated resource planning. Several proposals have been made that incorporate one or more of the following factors:

1. Utility recovery of the lost revenue (difference between revenue foregone because of reduced consumption and reduced operating costs) caused by DSM programs;
2. Recovery of the utility costs to operate DSM programs; and
3. Provision of financial incentives to utility shareholders for exemplary delivery of DSM services.

The underlying idea is that utilities should operate under regulatory and ratemaking practices that make it financially attractive for them to implement all aspects of their integrated resource plan, not just acquisition of supply resources [5, 6]. The National Association of Regulatory Utility Commissioners (NARUC) plans to develop recommendations on the merits of such proposals by the end of 1989.

Additional work is needed to assess the pros and cons of different incentive schemes. PUCs in a few states have approved utility tests of different ratemaking incentive schemes; evaluation of these experiments will provide valuable insights on the potential benefits of these approaches. In addition, utility-specific data and financial simulation models should be used to analyze various methods that reward utility shareholders for successful implementation of integrated resource plans. These analyses should focus on treatment of lost revenues caused by a utility's conservation programs and on how these revenues are recovered from different rate classes.

TECHNICAL SUPPORT

A variety of technical problems complicate IRP. One important methodological issue is the proper choice and

use of computer models to screen individual resources, to develop resource portfolios, and to conduct detailed analysis of a few attractive resource portfolios. The Electric Power Research Institute (EPRI) has developed several screening models and integrated planning models. These integrated computer models encompass the functions of previously separate load-forecasting, capacity-expansion, production-costing, and financial-planning models (Fig. 2). The Bonneville Power Administration uses an integrated Conservation Policy Analysis Model to assess alternative DSM strategies for the Pacific Northwest electric system.

The treatment of uncertainty is also very important because uncertainties affect utility resource-acquisition decisions and affect customer electricity costs. According to an ORNL review of several long-term resource plans, utilities use a variety of scenario, sensitivity, portfolio, and probabilistic methods to treat uncertainty in their planning [7].

The risks and uncertainties, both perceived and real, of different demand and supply resources need to be compared. This would include an assessment of the benefits of lead time, unit size, and flexibility for different resources.

Integrating DSM resources into the resource plan is difficult because of differences between demand and supply resources in unit size, capital cost, construction time, operating cost, reliability, and dispatchability.

Because the amount and quality of data on demand and supply resources differ so much, more efforts are needed to enhance the information used in IRP. The availability, reliability, load-shape impacts, unit size, lead times, costs, and other characteristics of various resources, especially DSM options, need to be better defined.

Because there are few publications that report on IRP, it is difficult to learn about approaches used by other utilities and PUCs; this is an especially difficult problem for most PUCs and for small utilities, which have only modest staffs. To assist PUCs and utilities in developing and reviewing long-term resource plans, LBL is helping the New York Public Service Commission review utility DSM and integrated-resource plans [8]. And ORNL is reviewing the long-term resource plans and short-term action plans of about 30 electric utilities.

Utility planning models should be reviewed and compared in terms of their technical capabilities, relevance to different aspects of the planning process, ease of use, data requirements, cost, and other factors. Such a review would aid utility planners in their selection of suitable computer models. In addition, it would help to review and document the plan preparation and filing

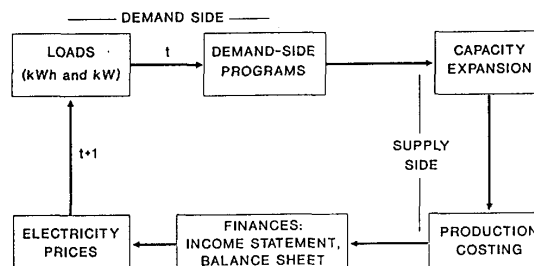


Fig. 2. Schematic of a typical integrated resource planning approach, showing the different submodels; t refers to the year of analysis.

guidelines currently used in various states and to evaluate the extent to which they address pertinent planning methodology, modeling, and data requirement issues. In other words, are PUC rules on IRP leading to useful plans that improve utility decisions on resource acquisitions?

Training workshops should be conducted for PUC and utility staff on the technical components of IRP methodologies, such as use of planning models, end-use forecasting, and DSM resource assessment, building on the projects noted above.

Finally, new planning methods are being developed. For example, EPRI is conducting projects on integrated value-based planning, which emphasize "service options that maximize both the value received by customers and the [utility] net earnings resulting from these sales" [9].

INSTITUTIONAL ARRANGEMENTS FOR IRP

If IRP is to develop and mature in an efficient manner, the successes and failures of different utilities and PUCs need to be documented and shared. A few groups have surveyed states that have established IRP processes [10,11]. In addition, NARUC published a handbook on LCUP that discusses some of the principal approaches currently in use [3]. However, these efforts do not address the regulatory and institutional aspects of IRP.

It is important to analyze IRP implementation where it has been practiced the longest (e.g., Wisconsin, Maine, Nevada, and the Pacific Northwest) to learn what

mechanisms lead to successful plans. This analysis should assess short-term action plans as well as long-term resource plans. In addition, the public involvement processes adopted by different utilities and PUCs should be reviewed, comparing the types of groups involved and the costs and benefits of their participation in utility planning. Finally, an information and document data base consisting of IRP legislation, rulemakings, rate cases, resource plan hearings, and similar activities should be created.

As DSM programs mature, the need for convenient access to high-quality, comprehensive, and timely technical and program data will increase. Some important first steps in this direction include EPRI's Demand-Side Information Service and the Northeast Region Demand-Side Management Data Exchange (NORDAX). These reference systems could be more closely integrated through a cross-referencing capability that allowed an online user to access more than one system without redefining keywords and without wasting time on duplicate entries.

Collaborative efforts involving diverse organizations are a valuable way to gain consensus on controversial issues, such as the need for new power plants and the size of a utility's conservation program. In the Pacific Northwest, the Northwest Power Planning Council and the Bonneville Power Administration have worked closely with each other, with the region's public and private utilities, and with other organizations on utility planning issues. More recently, the New England Electric System and the Conservation Law Foundation established a collaborative project on utility energy-efficiency programs, that is similar to arrangements that the Foundation has with other utilities in New England.

Networking among IRP practitioners and analysts has greatly improved during the past few years. To date, EPRI and DOE have cosponsored four DSM conferences. NARUC held its first LCUP conference in April 1988; a second conference was held in September 1989. The biennial Summer Study of the American Council for an Energy-Efficient Economy and The Energy Program Evaluation: Conservation and Resource Management conferences have also been important discussion forums for IRP issues. DOE also provided cost sharing for several collaborative efforts in Rhode Island, Illinois, Wisconsin, and Michigan [12].

Preparing and regularly updating a list of reference sources that summarizes the major features, contents, and organization of the various online and hard-copy sources of IRP-related bibliographic and project information would aid IRP technology-transfer processes. Identifying (and, where possible, resolving) major gaps or inconsistencies in coverage of IRP topics by the existing

reference sources would also be valuable. So too would providing the reference services with abstracts of key items from the unpublished literature (e.g., reports prepared by utilities or consulting firms). Finally, it would help to expand networking, conferences, and other collaborative activities among IRP practitioners.

DEMAND-SIDE INPUTS TO PLANNING

The quality of data used in IRP needs to be significantly improved, especially on the demand side. PUCs share responsibility with utilities to ensure that DSM programs are carefully planned and evaluated, so that reliable data on the unit cost and size of resource options are available. Reviews of utility plans reveal important deficiencies, such as the lack of data for certain end uses and sectors, limited experience in screening and interpreting DSM data, and lack of guidelines to ensure quality control. Improved DSM data are needed with respect to baseline energy use (e.g., end-use load shapes and demographic and economic data), DSM technologies (e.g., energy and load-shape impacts and costs), and participation in utility DSM programs (e.g., penetration rates by market segment).

Utility planners require detailed data on energy end uses and on the underlying factors affecting energy demand to confidently incorporate DSM options into the utility's resource mix. Adequate baseline data (e.g., hourly loads by end use) are important for assessments of DSM technology performance, DSM program participation, and utility-system-load impacts. Data are also needed on the electricity-using equipment, buildings, and demographic/economic characteristics of building occupants.

Many assessments of end-use efficiency and load-management technologies have been undertaken by EPRI, the national laboratories, and other organizations, such as the Rocky Mountain Institute. One convenient way of representing the DSM potential is through supply curves of conserved energy or peak power. Such curves show the size of the resource that is available as a function of its cost in ¢/kWh or \$/kW, which can then be compared with supply options. Most case studies of DSM resources concentrated on the residential sector; thus, the commercial and industrial sectors are poorly understood. In addition, coverage of individual end uses and technologies is uneven and incomplete.

Perhaps the greatest need for additional data concerns the costs, effects, and cost-effectiveness of alternative utility DSM-program designs. A few types of programs (e.g., utility rebate program [13]) for particular market segments have been reviewed. EPRI assessed lessons learned in residential and commercial sector programs [14], while results from many individual evaluations of

utility and government programs are reported at the major DSM conferences. The Bonneville Power Administration conducts what is probably the most comprehensive and successful DSM evaluations of all. NORDAX produced a data base with information on almost 100 different DSM programs run by 17 utilities. DOE also funded several evaluations of utility programs by ORNL, LBL, and Argonne National Laboratory.

To improve data on baseline electricity use and end-use technologies, more effort is needed to identify ways to transfer load-research results from one location to another. Efforts to compile, analyze, compare, and publish measured end-use load data from many sources, and to fill the most important gaps in end-use load profile data (e.g., cooling and "miscellaneous" end uses) should be encouraged; data for the commercial and industrial sectors are especially needed. Work is needed to develop information on cost-effective monitoring and analysis methods (e.g., accurate methods of disaggregating whole-building hourly loads by end use and ways to manage large end-use-monitoring data sets).

A comprehensive list of technologies that can be included in utility DSM plans should be prepared and the list should be regularly updated. Each entry should include technology assessments, field performance data, comparisons of actual vs predicted savings, and costs.

Periodically surveying utility program activities would provide valuable information on the costs and performance of DSM programs. These surveys should be used to document successful DSM programs and the reasons for their success. These surveys should also be used to estimate the fraction of DSM-program participants that would have adopted the recommended energy-efficient actions without the utility program and to ensure consistency between load forecasting and DSM planning. Finally, guidelines and procedures should be developed for program monitoring, process and outcomes evaluations, pilot project experimentation, and other aspects of improved program design and analysis.

ENVIRONMENTAL AND SOCIAL FACTORS

Failure to consider external factors is an important shortcoming of current IRP practices. This failure often leads to outcomes that are socially suboptimal because many resource options entail significant social costs. Moreover, there are significant differences in the environmental effects (e.g., on air quality, water quality, and land use) of various electricity-supply options. The need to reduce environmental impacts may require a planning approach that includes environmental as well as other costs. Such a broadened approach should also encompass possible regional economic benefits associated

with electricity use and the income-distribution effects of different resource strategies.

The U.S. Congress recognized the importance of environmental factors by giving conservation resources a 10% bonus in economic calculations in the Pacific Northwest; thus energy-efficiency resources costing up to 10% more than the best supply alternatives are acquired [15]. The Wisconsin Public Service Commission recently adopted a similar approach that gives conservation a 15% credit relative to fossil-fuel power plants. Finally, the New York Public Service Commission recently approved utility proposals for competitive bidding for new power supplies that assign environmental factors between 15% and 20% of the total points used to rank proposals [16].

In designing acid-rain-abatement policies, reducing emissions at least cost is important to minimize burdens on ratepayers and regional economies [17]. This objective requires comparison of the cost of pollution control with the cost of alternative resources.

Ultimately, the specter of global warming may lead to dramatic changes in IRP practices. For example, future utility planners may be required to develop resource plans that achieve specific carbon dioxide reduction targets.

Efforts that would help utilities and PUCs include environmental and social factors in IRP include a review of current IRP regulatory practices for incorporation of environmental effects, and a review of alternative approaches to coordination among the various federal, state, and local government agencies responsible for utility regulation and environmental protection. Existing information on the costs of producing and delivering different fuels should be compiled and presented in a consistent, \$/MBtu basis. This consistency would facilitate incorporation of environmental costs into IRP models. National and regional analyses should be conducted of different electricity supply and demand strategies to reduce emissions of acid-rain precursors and of carbon dioxide to see how least-emissions strategies differ in costs and environmental effects from least-cost strategies.

CONCLUSIONS

Integrated resource planning considers a much broader array of energy and capacity resources than traditionally planning approaches do, including end-use-efficiency and load management by utilities, transmission and distribution options, alternative pricing options, and dispersed power generation. Such broadened planning can yield enormous benefits to consumers and society: acquisition of resources that meet customer energy-service needs in ways that are low in cost, environmentally benign, and publicly acceptable. IRP as a planning and

regulatory process can also greatly reduce the uncertainties and risks faced by utilities and PUCs. Such benefits occur because of the diversity of resources considered, public involvement in the planning process, and cooperation among interested parties.

To fully realize these benefits, a number of technical and institutional issues need further development. Based on the detailed assessments in the LBL/ORNL report [4], discussed here, we suggest several areas as the primary long-term foci for expanded IRP efforts nationwide (Table 2).

Successful development and implementation of integrated resource plans can save billions of dollars a year for U.S. energy consumers, reduce the need to build large, expensive generation and transmission facilities, improve the financial performance of utilities, reduce emissions of greenhouse gases and other pollutants, enhance national security, improve economic productivity, and smooth relations between utilities and their commissions and customers. None of these benefits will occur overnight, nor will they be easy to achieve. But they are well worth working for, which is why utilities, PUCs, DOE, and other organizations should expand their efforts on long-term energy-resource planning.

Table 2. Long-term priorities for future work on integrated resource planning

Assess regulatory alternatives that reward utilities for successful implementation of integrated resource plans.

Expand training, networking, and other technology-transfer activities that share IRP successes, analytical tools, and innovative regulatory strategies among PUCs and utilities.

Encourage and document successful institutional arrangements for resource planning and implementation.

Develop information on the performance and costs of demand-side technologies and programs to help balance the information available on DSM and supply options.

Incorporate environmental and other social factors into resource planning.

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Eric Hirst was born in New York City in 1943. He holds a Ph.D. in Mechanical Engineering from Stanford University. At Oak Ridge National Laboratory since 1970, Hirst conducts research related to energy efficiency and electric-utility planning.

Charles Goldman was born in Los Angeles in 1951. He holds a M.S. in Energy and Resources from the University of California, Berkeley. Goldman is a staff scientist at Lawrence Berkeley Laboratory, working on utility planning and DSM technologies and programs.